How Do Late Donors Respond to Early Donors in Crowdfunding?

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Abstract

The application of crowdfunding to philanthropy has not yet been studied extensively. In this paper, we focus on the sequential nature of giving on crowdfunding platforms. On the one hand, this feature exacerbates late donors' incentives to free-ride on early donors' contributions. On the other hand, sequential giving provides an opportunity for leadership-giving by early donors. Economic theory states that lead donors can signal their information about the quality of the public good to downstream donors leading to a positive response to early donations by downstream donors. Moreover, late donors' conditional cooperation due to moral obligation, reciprocity, social pressure, social norm-compliance, inequality aversion, or self-image concerns can also induce a similar positive response. To understand the impact of leadership and donor behavior in the context of crowdfunding, we use data from a prominent crowdfunding platform to estimate early donations' effect on later donations to verify which one of these forces is the main driver of donor behavior in crowdfunding platforms. Our findings mainly support the dominance of free-riding.

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1 Introduction

Why people give to charities has been a long-standing subject of inquiry among economists. People have different motives for contributing to public goods in general and charitable giving in particular. The broadest distinction in the economics literature has traditionally been between pure altruism (utility from the public good) and various other-regarding motives (gaining utility from the act of giving). In classic altruism-based models, donors are expected to free-ride on early donations (Varian, 1994). However, Vesterlund (2003), Andreoni (2006), Krasteva and Saboury (2021) show that under information asymmetry about the quality of the public good, altruistic donors infer quality from the size of lead donor's gift and as a result contribute more when a large leadership gift is observed. Other-regarding motives can be divided into the warm-glow of giving (Andreoni, 1988, 1989, 1990) that depends only on the size of one's donation, and social motives that stem from considering how one's gift compares to others' contributions. While warm-glow does not induce any response to giving by others, social motives lead to conditional cooperation, i.e., responding positively to others' contributions. Most existing studies use laboratory experiments to investigate these motives (Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000; Charness and Rabin, 2002; Konow, 2010; Cooper and Kagel, 2016). However, to date, few empirical studies of large data sets have been conducted in this area.

In this paper, we study how late donors respond to early donors in a crowdfunding platform. We first develop a simple theoretical model to formally demonstrate the role of free-riding, conditional cooperation, and signaling in determining giving behavior. Then we empirically investigate the relative importance of these three forces by examining donor behavior in a rich crowdfunding database from DonorsChoose.org.[1] Our database contains a large number of fundraising projects that can be observed and compared, which makes it an ideal setting for an empirical investigation of charitable giving behavior. Moreover, the rather recent prevalence of crowdfunding in charitable fundraising makes it a valuable subject of inquiry on its own. One important characteristic of crowdfunding is sequential giving where each donor observes the sum of past contributions, which provides a setting to test classic free-riding. Another important aspect of most crowdfunding platforms, including DonorsChoose.org, is threshold giving, which means: a) projects will be funded only if contributions reach a given threshold (the amount asked by the fundraiser), and b) projects stay on the website for a limited time (up to four months in the case of DonorsChoose.org).

We find strong evidence in support of free-riding. In particular, we estimate a statistically significant negative impact of total accumulated past donations on donation size, which is

[1] DonorsChoose.org is an online crowdfunding platform extensively used by public school teachers across the USA to raise money for their classrooms by posting various projects. In fact, given the scope and broad use of DonorsChoose.org among low-income communities, DonorsChoose.org is referred to as "the PTA Equalizer" (Rivero, 2018). Moreover, this platform has the criteria the National School Board Association sets for best-in-class crowdfunding sites, such as financial transparency and accountability, privacy and safety, and integrity controls. For more details, see: https://help.donorschoose.org/hc/en-us/articles/360002942094-Resources-for-School-Board-Members.

consistent with "classic free-riding," i.e., donors' free-riding on the total of earlier donations. In other words, when a given donor arrives and observes larger past contributions, they infer a higher probability of the project being funded, which reduces their giving motives. In addition, we find that donation size responds negatively to time left to project expiration date, which is consistent with another form of free-riding. The more time left when a given donor arrives, the more likely it is for other potential donors to show up and contribute to the project. Thus, the donor in question would have less of an incentive to contribute. We refer to this propensity to free-ride on potential upcoming donations as "forward free-riding." Lastly, we estimate the impact of cumulative donations one week before a donor arrives, on their donation and do not find a positive impact which does not support quality signaling. In short, higher cumulative donations do not seem to be interpreted as a signal of quality.

To understand the different forces that affect one's giving decision in crowdfunding platforms, it is important to take a closer look at their structure. Each posted project has a requested amount determined by the fundraiser, which is the minimum donation required for the project to be funded. Additionally, each project has an expiration date after which, no more donations are accepted. In short, each project is funded only if total contributions reach a certain threshold within a fixed time period, both of which are observable by any potential donor who visits the website. Therefore, once a given donor arrives, they can infer the probability of public good provision (project being funded) based on cumulative past giving and time left to project deadline. At this point, the donor's giving decision would be determined as a result of the interaction between various (and potentially apposing) motives.

Altruism or the desire for provision of the public good is the earliest established motive for giving in economic theory. As is well known, altruism leads to free-riding behavior once a donor faces increasing giving by others. In the context of crowdfunding, total giving by past donors is directly observable while future donors' expected contributions can be inferred from time left to a project's expiration date. Therefore an increase in both total past donations and time left to expiration should reduce altruistic giving motives. However, when an altruistic donor is uncertain about public good quality, their response to earlier donations might be different.

It is reasonable to assume that when a project is posted, those who have inside information about it such as friends and family of the fundraiser, will contribute first. Thus, as shown first by Vesterlund (2003), such early informed donors will have an incentive to signal project quality through the size of their donation. As a result, late arriving donors interpret higher early donations as a signal of higher project quality, which could in turn alleviate free-riding behavior. Nonetheless, we should emphasize that each donor only observes the sum of past donations but not the size of each donation separately. Therefore, it is the size of the cumulative contribution (not the size of the last donation) that works as a quality signal. Hence, once a donor infers high quality by observing high past cumulative donations, they only need to contribute enough to keep the cumulative donations high and pass the signal through for the next potential donor to observe.

Other-regarding preferences can also influence giving behavior. Specifically, social motives that take into consideration the relative size of a donation to others' donations, induce a sort of reciprocal behavior that alleviates free-riding. In the context of crowdfunding, a given donor does not directly observe every individual contribution. Nonetheless, each donor can infer the average past gift size based on their observation of past cumulative giving and the time elapsed from when the project is posted. In short, higher cumulative giving during a shorter time from project posting (more time left to expiration) implies a higher average past gift, which would induce more giving by a donor who has an incentive to reciprocate others' gifts. Such incentive can be derived from moral obligation, social pressure, social norm-compliance, inequality aversion, self-image concerns or reciprocity (a tendency to reward kindness and punish unkind actions).

To test the relative importance of the giving motives discussed earlier, we use data from Donorschoose.org to estimate the effects of cumulative past donations and time left to expiration on the size of each donor's contribution. Our identification strategy takes advantage of the fact that donors would be unaware of the time left and accumulated donations prior to browsing the website; hence these variables are exogenous to any arriving donors' characteristics. While free-riding would lead to a negative effect of cumulative past donations and time left to expiration on donation size, both quality signaling and social motives work in the opposite direction. Hence, it is not straight forward to disentangle the latter two effects. Nonetheless, as discussed earlier quality signaling occurs not through one's donation but through cumulative donations. Thus, one approach to testing for the existence of quality signaling is to focus on the effects of cumulative past donations and time left to expiration on cumulative donations. However, the problem with this approach is that cumulative past donations are strongly correlated with cumulative donations. To alleviate this issue and weaken the correlation, we use lagged cumulative past donations until a week before a donor arrives.

We find that a one percentage point increase in time left (relative to the total project posting period) will decrease the amount contributed by 0.40 percentage point (relative to project provision threshold). Furthermore, a one percentage point increase in past collected contributions (relative to project provision threshold) leads to a reduction of 0.17 percentage point in the amount contributed. Lastly, our results show that a one percentage point increase in lagged cumulative past donations (until a week before and relative to project provision threshold) will reduce the cumulative contributions by 0.47 percentage point. All these findings strongly support the dominance of free-riding behavior.

Our paper contributes to the broad literature on charitable giving and givig motives. In particular, we contribute to the small but growing literature on crowdfunding as a charitable fundraising mechanism. Of course, the use of crowdfunding in business and marketing has been studied extensively.[2] However, the use of crowdfunding in charitable fundraising is more recent

[2]For instance, Strausz (2017) provides a mechanism design for crowdfunding under uncertainty and moral hazard. In a recent study by Deb et al. (2019), they design a reward-based crowdfunding model for a private good, and empirically examine the dynamic interactions of buyers and donors in crowdfunding using data collected

and unlike crowdfunding for businesses entails the problem of free-riding. Therefore, the latter requires specific scholarly attention that has not yet received broadly. Boudreau et al. (2015) provide a theory on crowdfunders' behavior and how the platform's design can help deal with free-rider problems. Meer (2014, 2017) investigates the price elasticity of giving, competition, and substitution between causes in crowdfunding. There are also papers that focus on crowd-out effects in crowdfunding (Meer and Tajali, 2021) and the impact of charitable crowdfunding on educational outcomes (Keppler et al., 2022). Recent studies have also explored donors' behavior in charitable giving crowdfunding platforms. Gleasure and Feller (2016) find that donations to organizations are more influenced by fundraising targets, while donations to individuals are more influenced by interaction-related factors. Beier and Wagner (2016) show the importance of the first days of a fundraising campaign in its success. Argo et al. (2020) find evidence of a "completion effect," i.e., donors contributing more to reach their personal fundraising targets. In a related study, Cryder et al. (2013) concentrate on the "goal gradient helping" motivation where donors contribute a larger amount in the last stage of a fundraising campaign. Similarly, Wash (2021) finds that individual donations are higher when they lead to project completion.

This article proceeds as follows: in Section 2, we discuss our theoretical model and its implications. We then describe the data and lay out our empirical strategy in Section 3, which is followed by the results in Section 4. Section 5 concludes.

2 Theory

2.1 Model

Fundraising for a threshold public good begins at time $t = 0$ and ends at time $t = 1$. Potential donors show up randomly following a homogeneous Poisson process with a mean rate of ν potential donors over the fundraising timeline. Let g_i represent the contribution of each donor i. The public good will be provided if the sum of all donations $G = \sum_i g_i$ is no less than a threshold G_0, and each donor i's utility will be:

$$u_i = \mathbb{1}_{G \geq G_0}[v(w_i - g_i) + V] + \mathbb{1}_{G < G_0} v(w_i) \tag{1}$$

2.2 Individual Contribution

Consider a potential donor i that arrives at time $t \in (0, 1)$ such that $g_{-i} = \sum_{j=1}^{i-1} g_j$ has already been contributed by previous donors. They will aim to maximize their expected payoff:

$$E(u_i) = p(g_{-i} + g_i, t)[v(w_i - g_i) + V] + [1 - p(g_{-i} + g_i, t)]v(w_i) \tag{2}$$

from Kickstarter. Other studies in the area of entrepreneurial crowdfunding platforms include Belleflamme et al. (2015); Moritz and Block (2016); André et al. (2017); Ellman and Hurkens (2019); Chakraborty and Swinney (2021).

where $p(g_{-i}+g_i,t) = Prob(G \geq G_0 | g_{-i}+g_i,t)$. The first order condition of a donor's problem will be:

$$p_1(g_{-i}+g_i^*,t)[v(w_i-g_i^*)+V] - p(g_{-i}+g_i^*,t)v'(w_i-g_i^*) - p_1(g_{-i}+g_i^*,t)v(w_i) = 0$$

$$\Rightarrow p_1(g_{-i}+g_i^*,t)[v(w_i-g_i^*)+V-v(w_i)] = p(g_{-i}+g_i^*,t)v'(w_i-g_i^*) \tag{3}$$

2.3 Classic Free-Riding

It is straightforward to see that $p_1(.,.) > 0$ and $p_{11}(.,.) < 0$.[3] Thus, if $v'(.) > 0$ and $v''(.) < 0$, the left-hand-side of Equation (3) that represents the marginal benefit of giving, will be decreasing in g_i^* and the right-hand-side (marginal cost of giving)— increasing. Hence, the first order condition will have a unique solution and the donor will contribute a positive amount, i.e., $g_i^* > 0$ if:

$$V > \frac{p(g_{-i},t)v'(w_i)}{p_1(g_{-i},t)} \tag{4}$$

In other words, one will contribute if the value of the public good is higher than their expected marginal cost of providing it. It is straight forward to see that the right-hand-side of Inequality (4) is increasing in g_{-i}. As a result, **g_i^* is decreasing in g_{-i}**.

2.4 Forward Free-Riding

Consider two different points in time, t_1 and $t_2 > t_1$. At any given level of cumulative donation $g_0 < G_0$, the probability of public good provision at time t_1 can be written as:

$$p(g_0,t_1) = Prob(g_2 = g_0)p(g_0,t_2) + Prob(g_2 = g_n > g_0)p(g_n,t_2)$$

where g_2 is the cumulative donation at time t_2. Moreover, $p(g_0,t_2) < p(g_n,t_2)$ since $p_1(.,.) > 0$. As a results, $p(g_0,t_1) > p(g_0,t_2)$. Thus, $p_2(.,.) < 0$. Moreover, intuitively, for a given level of g_0, the probability of provision is higher early in the process than when little time is left. Thus, one's contribution goes a longer way when t is high. Hence, $p_{12}(.,.) > 0$. Consequently, the right-hand-side of Inequality (4) is decreasing in t. As a result, **g_i^* is increasing in t**.

2.5 Conditional Cooperation

To incorporate motives driving conditional cooperation[4], each donor i's utility can be rewritten as follows:

$$u_i = \mathbb{1}_{G \geq G_0}[v(w_i-g_i)+V] + \mathbb{1}_{G<G_0}v(w_i) - c(\frac{g_{-i}}{\nu t} - g_i)$$

[3] The latter is due to the fact that $\lim_{g \to G_0} p(g,t) = 1$ and $\lim_{g \to G_0} p_1(g,t) = 0$

[4] Social norm compliance, social pressure, peer pressure, reciprocity, inequality aversion, self-image concerns, reputation concerns, etc.

where $\frac{g_{-i}}{\nu t}$ is the perceived average past gift, and $c'() > 0$. Thus, a potential donor i's expected payoff will be:

$$E(u_i) = p(g_{-i} + g_i, t)[v(w_i - g_i) + V] + [1 - p(g_{-i} + g_i, t)]v(w_i) - c(\frac{g_{-i}}{\nu t} - g_i) \tag{5}$$

The first order condition of a donor's problem will be:

$$p_1(g_{-i} + g_i^{**}, t)[v(w_i - g_i^{**}) + V - v(w_i)] + c'(\frac{g_{-i}}{\nu t} - g_i) = p(g_{-i} + g_i^{**}, t)v'(w_i - g_i^{*}) \tag{6}$$

Comparing equations (3) and (6), reveals that at g^*, the left-hand-side of equation (6) or the marginal benefit of giving will be greater than the the right-hand-side (marginal cost of giving). Thus, $g^{**} > g^*$. However, how g^{**} responds to changes in g_{-i} and t depends on the concavity of $c()$. Notice that the right-hand-side of equation (6), i.e. the marginal cost of giving, is increasing in g_{-i}. Thus, $\underline{g_i^{**}}$ **is increasing in** $\underline{g_{-i}}$ if and only if the following condition holds:

$$p_{11}(g_{-i} + g_i^{**}, t)[v(w_i - g_i^{**}) + V - v(w_i)] + \frac{1}{\nu t}c''(\frac{g_{-i}}{\nu t} - g_i) > p_1(g_{-i} + g_i^{**}, t)v'(w_i - g_i^{*})$$

In other words, convex reciprocal motives weaken a donor's classic free-riding incentives, and reverse the relationship between giving and cumulative previous contributions, if they are strongly convex:

$$c''\left(\frac{g_{-i}}{\nu t} - g_i\right) \geq \nu t\left(p_1(g_{-i} + g_i^{**}, t)v'(w_i - g_i^{*}) - p_{11}(g_{-i} + g_i^{**}, t)[v(w_i - g_i^{**}) + V - v(w_i)]\right)$$

Moreover, the right-hand-side of equation (6), i.e. the marginal cost of giving, is decreasing in t. Hence, $\underline{g_i^{**}}$ **is decreasing in** $\underline{t}$ if and only if the following condition holds:

$$p_{12}(g_{-i} + g_i^{**}, t)[v(w_i - g_i^{**}) + V - v(w_i)] - \frac{g_{-i}}{\nu t^2}c''(\frac{g_{-i}}{\nu t} - g_i) < p_2(g_{-i} + g_i^{**}, t)v'(w_i - g_i^{*})$$

In other words, convex reciprocal motives weaken a donor's forward free-riding incentives, and reverse the relationship between giving and time, if they are strongly convex:

$$c''(\frac{g_{-i}}{\nu t} - g_i) \geq \frac{\nu t^2}{g_{-i}}\left(p_{12}(g_{-i} + g_i^{**}, t)[v(w_i - g_i^{**}) + V - v(w_i)] - p_2(g_{-i} + g_i^{**}, t)v'(w_i - g_i^{*})\right)$$

2.6 Quality Signaling

The strategic consideration of quality signaling can also affect the size of donations. A donor can infer the otherwise unobservable quality of a public good through the size of cumulative past donations and time left. They would then have an incentive to pass on the quality signal to potential downstream donors by ensuring that the size of cumulative donations is high enough. The overall signaling game would be very complex since donors show up randomly and their individual donations are not visible. Each new donor only observes cumulative past donations and time left, not knowing the exact number of past donors. Moreover, the number of subsequent donors is uncertain as well. Therefore, donors can only partially infer the quality of the public

good and send fuzzy signals. Nonetheless, it can be shown that donors can infer higher quality from higher past donations and more time left.

Consider the simple case where a donor i infers a high expected quality, i.e., $E(V) = V_h$ when they observe $g_{-i} = g_{-h}$, and believe that $E(V) = V_l < V_h$ if $g_{-i} = g_{-l} < g_{-h}$. Then, if the Reily (least costly separating equilibrium) exists, the two types will separate by choosing to contribute g_h and g_l respectively. However, one should keep in mind that a donor's signal is not their contribution alone as that is not observable. Instead, the signal sent by donor i is $g_{-i} + g_i$ which is visible by the next donor. Thus, it should hold that $g_{-l} + g_l < g_{-h} + g_h$. Moreover, the signals should be incentive-compatible, i.e, the expected payoff of sending the low quality signal $(g_{-l} + g_l)$ should be equal to that of sending the high quality signal $(g_{-l} + g_{lh})$[5] when donor i observes the low quality signal, i.e.:

$$\begin{aligned} & p(g_{-l} + g_l, t|V = V_l)[v(w_i - g_l) + V_l] + [1 - p(g_{-l} + g_l, t|V = V_l)]v(w_i) \\ & = p(g_{-l} + g_{lh}, t|V = V_h)[v(w_i - g_{lh}) + V_l] + [1 - p(g_{-l} + g_{lh}, t|V = V_h)]v(w_i) \end{aligned} \tag{7}$$

As for when donor i observes the high quality signal, if $g_{-h} + g_h$ is the high quality signal and $g_{-h} + g_{hl}$ - the low quality signal then $g_h > g_{hl} = g_l + g_{-l} - g_{-h}$.[6] Thus given that $v''() < 0$, we get $v(w_i - g_h) - v(w_i - g_h - g_{-h} + g_{-l}) > v(w_i - g_l - g_{-l} + g_{-h}) - v(w_i - g_l)$, and since $g_{lh} = g_h + g_{-h} - g_{-l}$, we get $v(w_i - g_h) - v(w_i - g_{lh}) > v(w_i - g_{hl}) - v(w_i - g_l)$. Hence, Equation (7) implies the following:

$$\begin{aligned} & p(g_{-h} + g_{hl}, t|V = V_l)[v(w_i - g_{hl}) + V_h] + [1 - p(g_{-h} + g_{hl}, t|V = V_l)]v(w_i) \\ & < p(g_{-h} + g_h, t|V = V_h)[v(w_i - g_h) + V_h] + [1 - p(g_{-h} + g_h, t|V = V_h)]v(w_i) \end{aligned} \tag{8}$$

In other words, incentive-compatibility for the low-quality type, implies incentive- compatibility for the high-quality type, which is the single-crossing property required for the existence of a signaling equilibrium. Furthermore, the least costly separating equilibrium (the Reilly equilibrium) is the one that is guaranteed to satisfy the Cho-Kreps intuitive criterion. In turn, the Reilly equilibrium implies that when observing a quality signal, a donor's best response is contribute high enough to pass on the signal. In other words, **cumulative donations $g_{-i} + g_i$ should be increasing in past cumulative donations g_{-i}**.

3 Data and Empirical Strategy

3.1 Data

We use a dataset from DonorsChoose.org, an online crowdfunding platform extensively used by public school teachers across the USA to post projects and collect funding directly from the

[5] Notice that for the low quality type to send the high quality signal, since $g_{-l} < g_{-h}$, they have to contribute $g_{lh} > g_h$ such that $g_{-l} + g_{lh} = g_{-h} + g_h$.

[6] Notice that for the high quality type to send the low quality signal, since $g_{-l} < g_{-h}$, they have to contribute $g_{hl} < g_l$ such that $g_{-h} + g_{hl} = g_{-l} + g_l$.

public.[7] Since the founding of the platform in 2000, teachers at 86% of public schools in the United States have used it to post a project and have attracted more than $1 billion in donations from more than 5 million donors. The database of DonorsChoose.org contains detailed data on teacher project postings and donation dates and times.

Each project posting includes a detailed list of costs and supplies that would be purchased if the fundraising is successful along with a written description of the project, student needs, and the proposed use of the supplies. The project page also includes school information (such as its location and poverty level) and a photograph of the classroom. Moreover, Donorschoose.org staff and volunteers screen each project before it is posted publicly. Approved projects can be browsed by anyone who visits the website. Figure A1 shows the page of a representative project. If a project reaches its goal, DonorsChoose.org purchases the materials and ships them directly to the teacher. Otherwise, once a project expires prior to being funded,[8] donors have the option to receive a refund, contribute to another project, or allow DonorsChoose.org to select a project for them.

Our dataset contains detailed information on project posting by teachers (until the end of 2020), including project posted date, amount requested, and school location, as well as detailed data on donation amount and timing (date and time). After dropping donations whose recorded date is after the project expiration date due to a recording error,[9] our final sample includes 13,807,231 donation-day observations and 1,805,690 posted projects by 605,860 teachers from 78,478 schools. Table 1 presents summary statistics of the data.

Table 1: Summary statistics

	Mean	Std. Dev.	Median
Requested amount	787.91	5329.09	502.47
Donation amount	69.92	202.35	27.80
First donation amount	56.01	195.50	27.20
Last donation amount	143.97	872.90	54.25
Amount donated before the posted date	2.40	131.81	0.00
Amount donated on the same date as the posted date	79.23	274.30	0.00

Total observations 13,807,231. Donation and requested amounts are in January 2020 USD.

[7] DonorsChoose.org is available to all public school teachers free of charge. Thus, teachers do not incur any direct fundraising expenditures.

[8] Projects that do not reach their goal expire after four months.

[9] According to the representative of DonorsChoose.org, such observations are due to an error in coding the data. Hence, we drop 209,542 observations (less than 1.5% of the data).

3.2 Empirical Strategy

Equation (9) represents our main empirical model to estimate the effect of time left to project expiration and accumulated donation on a donor's contribution:

$$\begin{aligned} pct\ give_{dpt} = \alpha_p + \alpha_{my} + \beta_1(pct\ time\ left_{pt}) + \beta_2(pct\ past\ give_{dpt}) \\ +\beta_3(pct\ past\ give_{dpt} \times pct\ time\ left_t) + \epsilon_{dpt} \end{aligned} \tag{9}$$

where d and p are indexes for donor and project, and t is the donation date (as day-month-year). $pct\ give_{dpt}$ is donation size relative to the amount requested by the fundraiser (i.e., the public good provision threshold),

$$pct\ give_{dpt} = \left(\frac{Amount\ donated_{dpt}}{Amount\ requested_p}\right) \times 100 \tag{10}$$

and $pct\ past\ give_{dpt}$ is the total amount donated just before time t relative to the amount requested by the fundraiser.

$$pct\ past\ give_{dpt} = \left(\frac{Cumulative\ past\ donations_{dpt}}{Amount\ requested_p}\right) \times 100 \tag{11}$$

We also use the detailed information on the timing of postings and donations to calculate the expiration date and the number of days left to the expiration date.[10]. Then, we use Equation (12) to calculate $pct\ time\ left_{pt}$, which represents the percentage of posting period left before the project expires.

$$pct\ time\ left_{pt} = \left(\frac{expiration\ date_p - donation\ date_{pt}}{expiration\ date_p - post\ date_p}\right) \times 100 \tag{12}$$

Our main explanatory variables are $pct\ time\ left_{pt}$ and $pct\ past\ give_{dpt}$ that are both directly observable by the donors before they make their contribution decisions. In addition, we add the interaction term between these two variables to control for their effect on one another. We also include α_p for project fixed effects to control for time-invariant characteristics of projects, and control for the time effects by including month-year fixed effects (α_{my}). Lastly, we cluster the standard errors at the project level.

Our goal is to determine the relative importance of free-riding, conditional cooperation, and signaling on giving behavior in crowdfunding by estimating the model in Equation (9). Although donors' decision to browse DonorsChoose.org might not be random, information on the website regarding the projects would come to them as random. What we mean is that donors choose to browse the platform at a certain time but they do not have any prior knowledge about the amount collected thus far and time left to expiration for any of the projects. Thus, these two variables would be exogenous to the characteristics of a potential donor. Our identification strategy takes advantage of this plausibly exogenous variation.

One potential caveat to our identification strategy is that teachers can potentially advertise their postings and attract donors with prior knowledge about their projects. However

[10] As mentioned in Section 3.1, projects expire after four months if they are not fully funded. Hence, we create the expiration date as four months after the posting date.

luckily, DonorsChoose.org provides an opportunity for teachers to spread the word and jump-start pre-funding through the "Friends & Family Pre-Funding" option that allows fundraising before the DonorsChoose.org team reviews a project. All pre-funding contributions are applied to the project once it is officially on the website.[11] All such contributions are observable in our dataset, and only 12,477 donations (around 0.09% of total donation observations) are related to the pre-funding period. Thus, given their small size and number, donations from friends and family have an insignificant impact on our results.[12]

The two main coefficients of interest, are β_1 and β_2. Based on the discussions in Sections 2.3 and 2.4, both effects being negative can be interpreted as an evidence in support of free-riding. Conversely, the two coefficients being positive lends support to the dominance of social motives as shown in Section 2.5. However, as demonstrated in Section 2.6, while quality signaling alleviates free-riding, it operates through cumulative donations (as opposed to individual donations). Therefore, to test for the presence of quality signaling, we need to estimate the effects of cumulative past donations and time left to expiration on cumulative donations. To accomplish this task, at a first glance, one might be tempted to simply replace $pct\ give_{dpt}$ in Equation (9) with a new variable defined as follows to represent cumulative donations:

$$pct\ current\ give_{dpt} = pct\ past\ give_{dpt} + pct\ give_{dpt}$$

Yet unfortunately, $pct\ current\ give_{dpt}$ is strongly correlated with $pct\ past\ give_{dpt}$ by construction. To avoid this issue, we use lagged cumulative past donations, which is the sum of contributions to the project until a week before the donor in question visits the website ($pct\ lagged\ past\ give_{dpt}$). If quality signaling is present, donors should be passing the signal through by keeping cumulative donations high and as a result, lagged cumulative donations would have a positive effect on present cumulative donations in the following regression model:

$$\begin{aligned} pct\ current\ give_{dpt} = \alpha_p + \alpha_{my} + \beta_4(pct\ time\ left_{pt}) + \beta_5(pct\ lagged\ past\ give_{dpt}) \\ + \beta_6(pct\ lagged\ past\ give_{dpt} \times pct\ time\ left_t) + \epsilon_{dpt} \end{aligned} \tag{13}$$

The main coefficient of interest is β_5 that would be positive if there is quality signaling. Everything else about the model in Equation (13) is the same as the main regression model in Equation (9).

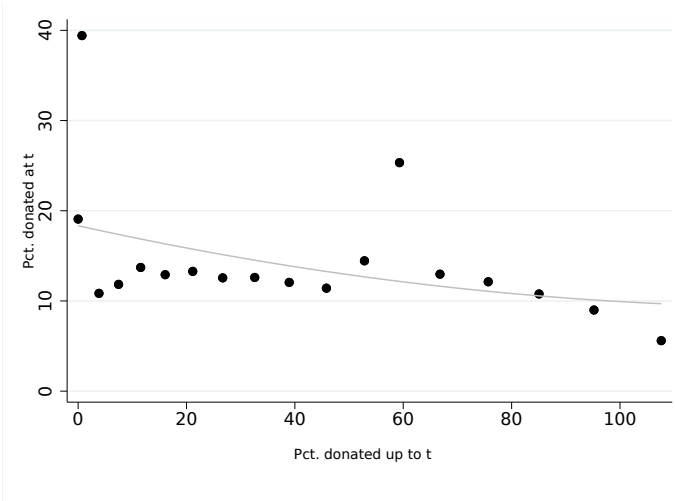
4 Results

In this section, we present the empirical results on how late donors respond to previous donations in crowdfunding. First, we show the relationship between giving and cumulative past donations up to that time using a binscatter plot (Figure 1). This figure shows that with more donations collected up to time t, a donor has a tendency to donate less at time t (free-riding).

[11] For details see: https://help.donorschoose.org/hc/en-us/articles/226500648-Friends-Family-Pre-Funding

[12] According to Table 1, average donation contributed before the posting date of a project is just USD2.40.

Figure 1: Relative donation at time t by relative past donations up to t



As discussed in Section 3.2, we estimate Equation 9 to find the impact of both time left and past donations on contributions. The results are presented in Table 2. Column 1 contains the main result, and shows that as the time to expiration increases by one percentage point relative to the expiration date, the amount contributed decreases by 0.4 percentage point relative to the project provision threshold. Furthermore, a one percentage point increase in past contributions leads to a reduction of 0.17 percentage point in giving at time t relative to the threshold. These findings demonstrate that a donor has less incentives to give with longer time left to the campaign's expiration or with larger past donations up to the time they visit the website.

In Table 2 Column 2, we estimate a model similar to Equation 9 that has the outcome variable changed to cumulative donations, i.e, the sum of donations collected in the past plus the donor's gift. In this model, there is no change in the effect of time left. However, there is a positive relationship between past donations and present cumulative donations. This result is not surprising given the correlation between these two variables by construction. If past contributions increase by one percentage point, a donor's gift increases total donations by 0.83 percentage points (relative to the project threshold). We also present a second version of these results where we convert the time left into quantile categories for our interaction term (Table A1). All of our results are consistent with the prevalence of free-riding.

Table 2: The impact of time left and past donations on contributions

	Pct. donations at t	Pct. cumulative donations at t
	(1)	(2)
Pct. time left to expiration date	-0.40***	-0.40***
	(0.00)	(0.00)
Pct. past give up to t	-0.17***	0.83***
	(0.00)	(0.00)
(Pct. time left) × (Pct. past give up to t)	0.00***	0.00***
	(0.00)	(0.00)
N	13807231	13807231
Donation-month-year FEs	Yes	Yes
Project FEs	Yes	Yes

$*p < 0.1 **p < 0.05 *** p < 0.01$.

This table presents the impact of time left and past donations on giving by estimating Equation 9. In Column 1, we use the percent donation relative to the requested amount as the outcome variable, while in Column 2, we consider the cumulative measure. All the columns include donation-month-year fixed effects and project fixed effects. Standard errors in parentheses.

Table 3: The impact of time left and lagged past donations on contributions

	Pct. donations at t		Pct. cumulative donations at t	
	(1)	(2)	(3)	(4)
Pct. time left to expiration date	-0.33***	-0.28***	-0.33***	-1.38***
	(0.00)	(0.00)	(0.00)	(0.00)
Pct. past give up to t	-0.04***		0.96***	
	(0.00)		(0.00)	
Pct. past give up to 7 days before giving	-0.03***	-0.02***	-0.03***	-0.47***
	(0.00)	(0.00)	(0.00)	(0.00)
(Pct. time left) × (Pct. past give up to t)	0.00***	0.00***	0.00***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
N	13807231	13807231	13807231	13807231
Donation-month-year FEs	Yes	Yes	Yes	Yes
Project FEs	Yes	Yes	Yes	Yes

$*p < 0.1 **p < 0.05 *** p < 0.01$.

This table presents the impact of time left and lagged past donations on giving. We use percent donations (relative to the requested amount) up to seven days as a measure for the lagged donations. In Column 1 and 2, we use the percent donation relative to the requested amount as the outcome variable, while in Column 3 and 4, we consider the cumulative measure. All the columns include donation-month-year fixed effects and project fixed effects. Standard errors in parentheses.

To investigate the existence of quality signaling, as explained in Section 3.2, we estimate Equation (13) that uses lagged past donations up to seven days before a donor's contribution relative to the project provision threshold as the main regressor (Table 3 Column 4). A one percentage point increase in lagged cumulative past donations reduces the cumulative contributions by 0.47 percentage point relative to project provision threshold, which does not provide any evidence of quality signaling. We also present the results of a similar regression that includes both past donations and lagged past donations in Column 3. Moreover, Columns 1 and 2 present the effect of lagged past donations on individual donation size. Overall, these findings point towards late donors choosing to free-ride rather than signal quality.

5 Conclusion

In this paper, we focus on donor behavior in crowdfunding platforms. We use data from DonorsChoose.org to estimate the impact of cumulative past donations and time to expiration on donation size. We find that donors reduce their contributions size in response to an increase in both variables which is consistent with free-riding behavior stemming from altruistic motives. Nevertheless, we should emphasize that the prominence of free-riding behavior and the partial crowd-out effect of past donations does not indicate the absence of other motives for giving. In fact, our simple theoretical analysis demonstrates that the net effect observed is a result of interaction between various giving motives and the direction of the effects simply points to the strongest driver of giving. Our results suggest that in the context of crowd-funding platforms, altruism (donors' focus on public good provision) is the dominant force. However, the literature on this topic is rather recent, and there is a need for further investigation of this research question.

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A Appendix

Figure A1: Sample of DonorsChoose.org Requested Project

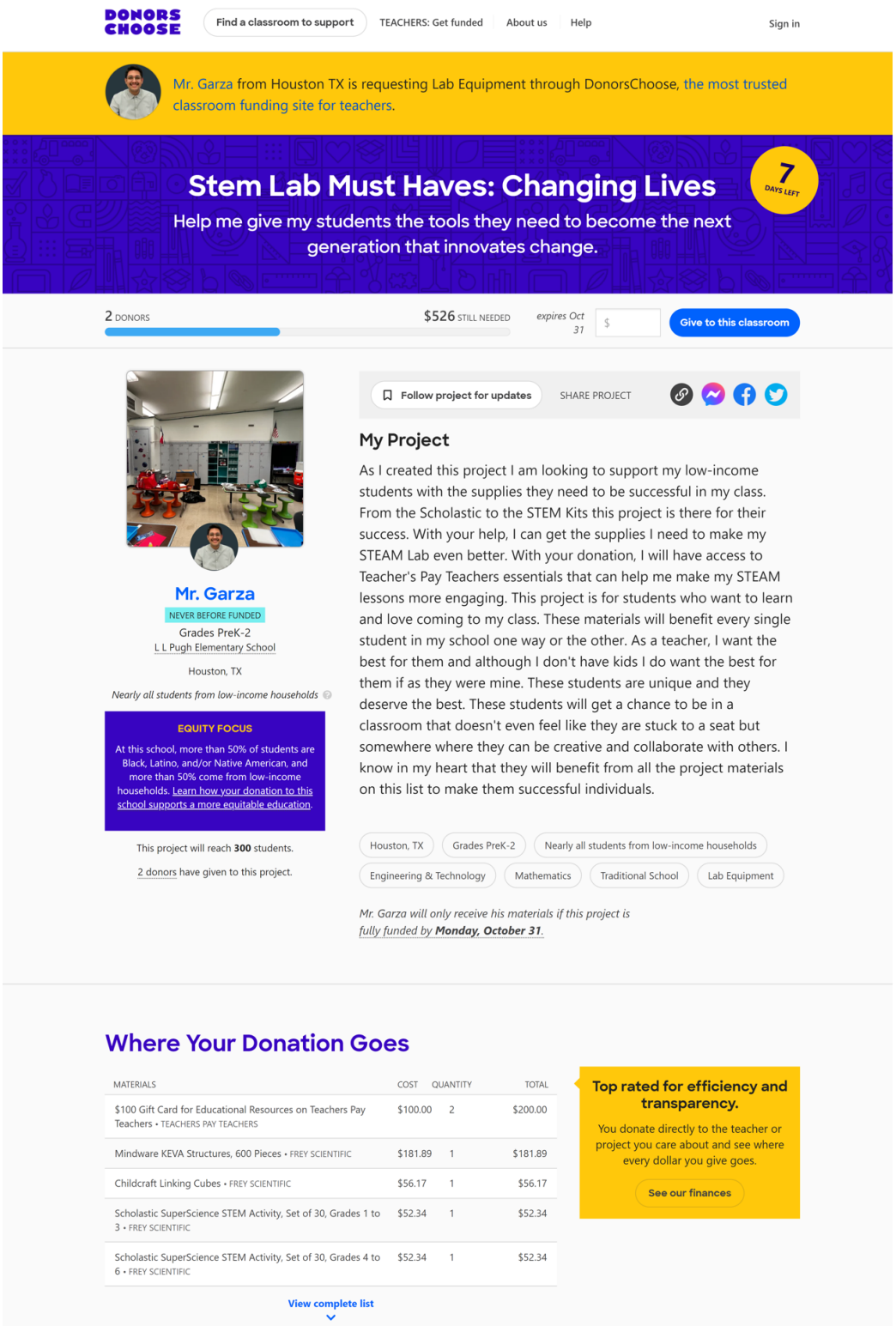

Table A1: The impact of time left (quantiles) and past donations on contributions

	Pct. donations at t (1)	Pct. cumulative donations at t (2)
Pct. time left to expiration date	-0.38***	-0.38***
	(0.00)	(0.00)
Pct. past give up to t	-0.11***	0.89***
	(0.00)	(0.00)
q2.(Pct. time)× (Pct. past give up to t)	0.09***	0.09***
	(0.00)	(0.00)
q3.(Pct. time)× (Pct. past give up to t)	0.10***	0.10***
	(0.00)	(0.00)
q4.(Pct. time)× (Pct. past give up to t)	0.08***	0.08***
	(0.00)	(0.00)
q5.(Pct. time)× (Pct. past give up to t)	0.05***	0.05***
	(0.00)	(0.00)
N	13807231	13807231
Donation-month-year FEs	Yes	Yes
Project FEs	Yes	Yes

$*p < 0.1 **p < 0.05 *** p < 0.01$. Standard errors in parentheses.